



**THE CHRISTOPHER COLUMBUS
CENTER OF MARINE RESEARCH
AND EXPLORATION**

AN ECONOMIC IMPACT STUDY

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It is our hope that the reader will find this report both informative and stimulating as we chart a course for Baltimore City, the state of Maryland and, most importantly, the United States in the application of science and technology for a better future.

EXECUTIVE SUMMARY

"The State of Maryland has an enormous financial investment in education and high-technology research, an investment which illustrates Maryland's eagerness to serve as the research capital of the nation. No better symbol of our investment exists than the Christopher Columbus Center of Marine Research and Exploration. The Christopher Columbus Center represents a combination of Maryland's dollars and talents that is sure to result in a better understanding of our world and solutions to some of our health, environmental, and industrial problems." (Governor William Donald Schaefer, quoted from Christopher Columbus Quincentenary Jubilee Commission report, p.5).

The Christopher Columbus Center of Marine Research and Exploration is proposed to be built in Baltimore's Inner Harbor in 1992 as part of a nationwide celebration of the 500th anniversary of Columbus's historic discovery of America. The Center's emphasis on research and exploration will also complement the spirit of exploration and the eternal desire to find new resources that Christopher Columbus exhibited during his historic voyage.

When completed, the Center will consist of several interdependent components --- Center of Marine Biotechnology, Center of Marine Archeology, Maritime Exhibition/Conference Center, Christopher Columbus Plaza, Seven-Foot Knoll Lighthouse, Marine Mammal Pavilion and Performance Tent. This economic impact report, however, focuses on the following three main components that are the core of the project:

Center of Marine Biotechnology (COMB),
Center of Marine Archeology (COMA),
Maritime Exhibition/Conference Center.

The following caveats are in order when analyzing the economic and fiscal impacts of the Christopher Columbus Center:

1. Economic and fiscal impacts are expressed in 1989 dollars, and are not affected by the actual starting dates of construction or operations.
2. Construction of a proposed 1,000-car garage in proximity to the Center is not included in the economic or fiscal impacts.
3. The economic and fiscal impacts of annual operations of the Maritime Exhibition/Conference Center are partly included in the annual operations of COMB and COMA.

4. The economic and fiscal impacts of the construction of the Christopher Columbus Center are expressed as net impacts. In other words, these impacts represent net new infusion of spending, job and the revenues in Maryland during the construction of the project.
5. The annual impact of operations is expressed as gross impacts, since a number of these operations currently exist in Maryland. Data and projections indicate that the scale of operations of each activity will substantially increase when relocated to the Christopher Columbus Center in Baltimore.
6. The existence of the Center will add to the critical mass necessary to attract additional tourism and business activity. It will also provide the stimulation necessary for business growth related to the Center's activities. However, these important activities are not easily quantified, and are, therefore, not included in the economic and fiscal impact estimates.

Construction Impact

During the construction phase, the Christopher Columbus Center of Marine Research and Exploration is estimated to have an economic impact of \$152 million, an employment impact of over 1,800 jobs and a fiscal impact of \$2.8 million.

Summary Table 1
Christopher Columbus Center Construction Economic Impact
- 1989 Dollars -

Total Construction Period Impact, not Annual	
<u>Economic Impact</u>	
Gross Output	\$152 million
Employee Income	\$51 million
Employment	1,821 (jobs)
<u>Fiscal Impact (Tax Revenues)</u>	
State Retail Sales Tax	\$420,000
State Personal Income Tax	1,580,000
Local Income Surtax	<u>790,000</u>
Total Tax Revenues	\$2,790,000

Source: DEED, Office of Research.

Operations Impact (Annual)

The impact of the annual operations of the Christopher Columbus Center is estimated to be \$57 million in gross output (or sales), \$27 million in employee incomes, 1,182 jobs and nearly \$2.2 million in tax revenues.

Summary Table 2
Christopher Columbus Center Operations Impact
- 1989 Dollars -

<u>Impact of Annual Operations</u>	
<u>Economic Impact</u>	
Gross Output	\$57 million
Employee Income	\$27 million
Employment	1,182 (jobs)
<u>Fiscal Impact (Tax Revenues)</u>	
State Retail Sales Tax	\$581,000
State Personal Income Tax	1,029,000
Local Income Surtax	504,000
Hotel Occupancy Tax (Local)	<u>65,000</u>
Total Annual Tax Revenues	\$2,179,000

Source: DEED, Office of Research.

CHAPTER I

CHRISTOPHER COLUMBUS CENTER
OF MARINE RESEARCH AND EXPLORATION
AN ECONOMIC IMPACT STUDY

Introduction

Of all the events that shaped and changed the modern world, none is probably greater than the discovery of America and the New World by Christopher Columbus. As Luis Marden notes in The Log of Christopher Columbus: "Some achievements of the human mind and spirit are so sublime they seem inevitable. They fall with the finality of fate into the pages of history and the memory of every school child. Even when we strip away the accretion of legend that sheathes the hard crystal of fact we remain filled with wonder. Such is the discovery of America by Christopher Columbus. The first footfall of Columbus on the shore of the New World echoed like a thunderclap down the centuries, and its reverberations have not yet died away" (International Marine Publishing Company, Camden, Maine, 1987). This single event expanded man's horizon, his knowledge of the world and the people who inhabit it. That eventful day in history was the 12th day of October in 1492, almost five hundred

years ago.

Christopher Columbus was a professional seaman, a master mariner supremely skilled at his trade. More importantly, Columbus had an insatiable drive to seek and discover new world frontiers and to venture into the unknown seas. His skills and experience as a mariner were essential for history to have taken the course it did, at a time when geographical knowledge and the tools of maritime trade were not highly developed. Only experienced seamen can fully comprehend what the Admiral did and how he did it.

In August of 1492, Christopher Columbus, driven mainly by his own ambition, richly sponsored by his government, sailed westward for the Far East. His spirit of exploration, undaunted by the hardships at sea and doubting sailors, brought him to America ten weeks later. What helped his mission overcome all odds were his mastery of the science and art of seamanship, his spirit of exploration, his eternal desire to find new resources (including the ever elusive gold) and to confront the unknown.

"Such a spirit burns in America today," as the Christopher Columbus Quincentenary Jubilee Commission notes, "a spirit that will soon find expression in the founding of the Christopher Columbus Center of Marine Research and Exploration, an international center of marine research and education dedicated to state-of-the-art science and matchless exhibition." The

Center is scheduled to open in Baltimore in 1992, the 500th anniversary of Columbus's historic landing.

The Center is forged as a partnership of local, state and federal governments, universities and institutes, and private enterprises, to usher in a new era of marine research and exploration. Just as Columbus's mission brought him to America, the Center is envisioned as taking us to a new horizon finding new resources, and building a better future for mankind. As Loren Eiseley put it, "If there is magic on this planet, it is contained in water."

Components of the Christopher Columbus Center

The Christopher Columbus Center of Marine Research and Exploration will be located in Baltimore's Inner Harbor. The Marine Mammal Pavilion, an extension of the National Aquarium in Baltimore, is already under construction on Pier 4. Also located in and around the Center will be a plaza, a seven-foot knoll lighthouse, Harrison's Hotel, a performance tent and ships of exploration. The main Center is proposed to be built on Piers 5 and 6.

This economic impact study focuses on three components of Christopher Columbus Center of Marine Research and Exploration which will be housed at the main Center, namely:

- o Center of Marine Biotechnology
- o Center of Marine Archaeology
- o Maritime Exhibition/Conference Center

Center of Marine Biotechnology (COMB)

The centerpiece of the Christopher Columbus Center will be the Center of Marine Biotechnology or COMB. The Center was established, as part of the Maryland Biotechnology Institute, on July 1, 1985, and is presently located at the Community College of Baltimore.

The Maryland Biotechnology Institute (MBI) is a component of the University of Maryland. The main office is currently located at the College Park campus. MBI currently has five components: Center for Advanced Research in Biotechnology (CARB) located in Shady Grove; Center of Marine Biotechnology (COMB) currently located at the Community College of Baltimore; Medical Biotechnology Center (MBC) located at 618 W. Lombard Street Baltimore; Center for Agricultural Biotechnology (CAB) located at the University of Maryland College Park (Patterson Hall); and Center for Public Issues in Biotechnology (CPIB) located at University of Maryland Baltimore County.

Current plans call for the MBI itself and two of its

components (COMB and CPIB) to be relocated to the Christopher Columbus Center in Baltimore's Inner Harbor. CARB is located in its new quarters in Shady Grove, while MBC and CAB will be relocated elsewhere from their present quarters when new facilities, planning of which is underway, are available for occupancy.*

The Center of Marine Biotechnology will be the main component of MBI at the Christopher Columbus Center. The senior faculty research personnel of COMB will consist of staff scientists, and joint appointees with the academic departments at the University of Maryland and the Johns Hopkins University. Major areas of research emphasized at COMB are the molecular biology and molecular genetics of:

- o growth, development and reproduction of marine eukaryotes
- o marine microbial products and processes,
- o interrelationships between marine organisms, and
- o microorganisms from extreme environments.

COMB scientists are studying the molecular basis of growth and development in commercially important marine finfish and shellfish. For example, the growth rate of fish has been accelerated significantly with the use of fish growth hormone produced by recombinant DNA techniques, and production of transgenic fish developments that hold great promise for the aquaculture industry. In order for fish and shellfish species to

be adapted to aquaculture, an understanding, if not control, of the reproductive cycle is necessary. Therefore, efforts are being directed at determining the molecular basis of internal (e.g., endocrine) and external (e.g., environmental) factors which affect or control the reproductive cycle of marine finfish and shellfish. Another research program concerns the molecular biology of marine algae, especially that concerning growth and development of macroalgae.

Scientists at COMB are examining ways to increase and improve the food supply from the sea, and are developing lifesaving pharmaceuticals to fight such disease as cancer and AIDS.

The laboratory for such research requires biodiversity --- that is, the wealth of variations expressed in millions of plants, animals and fish species that can be tapped for research. Here is where marine biotechnology offers a special advantage --- the world's oceans have more kinds of plants and animals, and in greater abundance, than any other habitat on earth.

Among the first scientists to recognize this great potential was Dr. Rita R. Colwell, Director of the Center of Marine Biotechnology and the Maryland Biotechnology Institute. An international leader and pioneer in the field of marine biotechnology, Dr. Colwell ushered the field into existence with a 1983 paper, "Biotechnology in the Marine Sciences," published in Science. COMB's exclusive focus on technology implications of

marine science provides a natural link to industrial and economic development. Indeed, part of the Center's mission is to forge such links and to make them stronger.

This kind of thinking has already borne fruit with the spin-off of a biotechnology company whose product, a marine bacterium-based underwater adhesive, was developed by scientists from the Center of Marine Biotechnology and the University of Maryland and an oyster-growing company employing biotechnology applications to aquaculture.

These efforts are drawing notice around the world --- from governments, from academia and industry alike, and in just three years, the Center has garnered more than \$10 million in federal grants and contracts, including a five-year, \$6.7 million grant from the U.S. Department of Defense University Research Initiative Program through the Office of Naval Research to investigate the molecular biology of marine organisms and processes and to train graduate and postdoctoral fellows. Cooperative agreements have been established with France, Taiwan, Japan, Chile, Argentina, Brazil, Peoples Republic of China, Federal Republic of Germany and Thailand. Graduate students at COMB may earn their M.S. and/or Ph.D. through the University of Maryland or Johns Hopkins University.

The Center has also induced a competitor to enter the field. Recently, Japan's Ministry of International Trade and Industry

committed over \$600 million to marine biotechnology, based on Dr. Colwell's COMB model. The Japanese have cited a mammoth potential market for marine biotechnology. The Christopher Columbus Center is asking for funding to retain a three to five year United States lead in the area.

The following are examples of research currently underway at the Center of Marine Biotechnology:

- o marine pharmacology
- o aquaculture
- o ocean pollution
- o replenishing native oyster stocks
- o industrial processing at high temperatures
- o marine biofouling
- o diagnostic testing

These kinds of research, like the development of vaccines early in this century, can once again position the United States to lead the work in the compassionate application of human ingenuity.

Oceanographic research vessels from other marine stations of the United States and foreign countries, as well as the RV Ridgely Warfield of the University of Maryland, will dock at Piers 5 and 6.

The Center of Marine Biotechnology will open in 1992 as a symbol of America's willingness to lead, not just compete, in a vital area of world technology. And, as a high tech campus located in the middle of a great American city, it will spawn economic development and signal to all citizens of the region their place in a global marketplace.

The Center is already working with local colleges and universities to set up training programs in biotechnology and other sciences. So the Center takes a bold, innovative step towards the problem of job training in a high tech future.

Center of Marine Archaeology

Shipwrecks contain valuable information about history, people and maritime voyages, as well as artifacts of daily life abandoned under difficult circumstances. In the process of exploration and recovery of shipwrecks we also expand our knowledge base on the techniques of exploration, recovery and preservation of marine artifacts. The Federal Abandoned Shipwreck Act of 1987 asserts the title of the United States to certain abandoned shipwrecks and finds that the states are responsible for the management of shipwrecks in their own waters. In the Fall of 1988, therefore, the Maryland Historical Trust in cooperation with the National Oceanic and Atmospheric Administration (NOAA) created a marine archaeology project to be

located at the Christopher Columbus Center. This project will be coordinated by the Maryland Historical Trust, NOAA, and the University of Maryland Baltimore County.

The Center of Marine Archaeology is proposed to be located on the eastern side of Piers 5 and 6. The Center will house classrooms for students in marine archaeology and space for marine archaeologists to develop engineering technologies appropriate to the excavation of relics and wrecks. It will also contain space for continuing public exhibition.

The Center's proposed staff will consist of research personnel, archaeologists and anthropologists, members from the Maryland Historical Trust and the National Center for Maritime Preservation Technology. The Center will also have a large contingent of divers and volunteers who will work on specific projects. In addition to applied research and exploration, the Center of Marine Archaeology will offer both the Master's and Ph.D. degrees in marine archaeology through the University of Maryland, Baltimore County. The Center of Marine Archaeology will have four components:

- o National Center for Maritime Preservation Technology
- o Graduate Program in Marine Archaeology
- o Institute for Marine Archaeology
- o Maryland Maritime Archaeology Program

The Center of Marine Archaeology will also house a display area. This area will display artifacts of marine exploration that have been stabilized and are being researched for eventual permanent display. As part of its mission, the Center will showcase techniques and tools used in modern exploration, recovery, stabilization and conservation of maritime artifacts. Besides providing information about maritime events of the past, such explorations can bridge the gap between the known and the unknown in historic maritime voyages. The display area will be open to the public, possibly seven days a week.

The Center of Marine Archaeology also proposes to display one or more replicas of ships of historical voyage (probably a Chinese junk that closely resembles Marco Polo's ship Cocochin). Discussions are currently under way to determine which of these ships will be obtained for permanent display at the Christopher Columbus Center. The display, although not directly associated with the Center of Marine Archaeology, will be part of the Christopher Columbus Center. These ships, on display at the western edge of Piers 5 and 6, will include the Coast Guard cutter Taney, the submarine USS Torsk, and the lightship Chesapeake. These ships will be open to the public.

Maritime Exhibition/Conference Center

The Maritime Exhibition/Conference Center will showcase

research in progress throughout the Christopher Columbus Center. On display will be vessels and relics dating back to the Columbus era. Continuing exhibitions will feature marine biotechnology and its applications.

The Maritime Exhibition/Conference Center will be interactive and participating in nature --- not a traditional, "glass case" museum. The significance of the Exhibition from an economic impact perspective will be its attraction as a tourism destination. The location in Baltimore's Inner Harbor of a large mix of tourist and visitor attractions --- the Maritime Exhibition/Conference Center, the Christopher Columbus Plaza (which will replicate the Chesapeake Bay), the National Aquarium, Marine Mammal Pavilion, Maryland Science Center, the malls, shops and water attractions at the Inner Harbor, the Convention Center, scores of hotels and other attractions --- will create the critical mass necessary to establish Baltimore as a major tourism destination.

The adjoining conference center will be a common teaching and conference area for those organizations working in the Columbus Center. It will host national and international symposia for scientists, scholars and students in the marine sciences. The Conference Center will be a major gateway for the assembly and dissemination of knowledge in marine biotechnology, marine archaeology and related disciplines. Also, from an economic development perspective, the Conference Center and conferences

attracting delegates even larger than the Conference Center capacity will have significant economic and fiscal impact on the local and Maryland economy due to conference-related spending of visitors and tourists. Time is especially crucial as 1992 approaches. There will be no World's Fair or other major exhibition in the United States for the Columbus Quincentenary. Therefore, there are great opportunities for corporate and public funding.

Scope of the Study

The Christopher Columbus Center as proposed, will have several interlinked components, each unique and yet part of a complete system. The Center of Marine Biotechnology will be the largest single component and its centerpiece, with others closely tied to it. Besides the Center of Marine Biotechnology, the Christopher Columbus Center of Marine Research and Exploration will contain the following: Center of Marine Archaeology, Marine Mammal Pavilion, Maritime Exhibition/Conference Center, the Christopher Columbus Plaza, Conference Center (with a 1,000-car parking garage), ships, seven-foot knoll lighthouse and a Performance Tent. Harrison's, a privately owned hotel and restaurant, not part of the Christopher Columbus Center, will be located near the end of Pier 5. It may be noted that some of the facilities already exist or are under construction, such as the Marine Mammal Pavilion, Harrison's and the Performance Tent.

Other's, such as display of ships and the lighthouse, and the plaza are difficult to quantify in terms of additional tourism or the economic impact they might generate.

This report, therefore, focuses on the three main components of the Christopher Columbus Center that do not presently exist at the site. These three are:

- o Center of Marine Biotechnology (COMB)
- o Center of Marine Archaeology (COMA)
- o Maritime Exhibition/Conference Center

Detailed data on construction were available for all three components. Detailed operations data were only available for COMB and COMA, but operational data for the Maritime Exhibition/Conference Center were sketchy and often included in the estimates for COMB and COMA.

The economic impact estimates, for each component of the Christopher Columbus Center included in this study, are derived from the Maryland Economic Impact Model (described below). The model was used to estimate the economic and fiscal impacts of the construction phase as well as the annual operations of the Christopher Columbus Center. The economic impact indicators include direct output or sales, direct employment (jobs), direct payroll, total statewide gross sales, total statewide employment and total statewide payroll. The fiscal impact indicators

include state receipts from retail sales and state personal income taxes. The fiscal impact also includes local revenues from both personal income surtaxes and hotel occupancy taxes.

It may be noted that economic and fiscal impacts of construction are only relevant during the construction phase of the Christopher Columbus Center. Construction may take 30 months or longer, and components may be phased in over additional months. The economic and fiscal impact estimates are not divided into specific years. Rather, these are totals for the entire construction process, expressed in 1989 dollars. The annual operations impacts, in terms of spending, payroll, jobs and tax revenues, will take place every year assuming that the operations maintain their current level of activity in the future. One may view these annual cash flows as representative for the initial three or four years of full-time operation. The level of operations will increase over time, and concurrently the economic and fiscal impacts of annual operations will also increase. Finally, we must note that all economic and fiscal impacts are expressed in 1989 dollars; there are not adjustments for possible future inflation.

Research, Exploration and Spinoffs

The economic value for the Christopher Columbus Center of Marine Research and Exploration is not limited to its spending,

payroll, employment and tax impacts. The basic foundation of research and exploration of the Center is applied work --- i.e., the application of marine research and exploration to the discovery of new ideas, products and processes, with the sea as the laboratory and a seemingly limitless number of applications. As these applications, research and exploration yield new ideas, new techniques, new products and new processes, many will find commercial application for the benefit of mankind. We have already seen the result of this applied research with the spin-off of a biotechnology company whose chief product, a marine bacterium-based under-water adhesive, was developed by COMB scientists and an oyster production company utilizing biotechnology applications to aquaculture. Other similar spin-offs related to marine research and exploration can surely be expected in future years when the Center becomes a reality.

A second set of economic benefits will result from firms willing to locate in the vicinity of the Center, in order to benefit from direct and day-to-day interactions with scientists and researchers at the Christopher Columbus Center. The Center of Marine Biotechnology has already identified five companies which may relocate to Baltimore when the Christopher Columbus Center becomes operational.

Finally, a center of such international repute as the Christopher Columbus Center of Marine Research and Exploration also brings close ties with world-renowned researchers,

scientists, universities and research institutes. COMB has already established links and joint research agreements with scientists and research institutes in Japan, France, Taiwan and Thailand, PRC, FRG, Brazil, Chile and Argentina.

The Christopher Columbus Center of Marine Research and Exploration therefore is more than a national center; it is an international center. In today's competitive global economy, other countries are not standing still. Given the keen American spirit of inventiveness, the Christopher Columbus Center can help the United States meet these international challenges, and position us as the world leader in developing resources of the future in the sea.

The very core of the Christopher Columbus Center's contribution to Maryland and to the U.S. is the expansion of knowledge that leads to innovative products, processes and applications. Yet, it is very difficult at this time to estimate the economic value of potential spin-offs and firm locations, and to quantify the economic benefits of being an international center of marine research and exploration. This study focuses on the Christopher Columbus Center itself, and more specifically, on the three major components of the Center that are identified above. Thus, the economic and fiscal impacts from construction and operations that occur at the site of the Christopher Columbus Center, while of impressive magnitude, are but the tip of the economic gain iceberg. Those within our society with a vision of

our future and willingness to undertake risk are the explorers of the twenty-first century. Discovery often necessitates sailing on unchartered waters.

The Model

The Maryland Economic Impact Model is a computerized technique for assessing the economic and fiscal impacts of projects and policy alternatives. This model is derived from the U.S. Government-financed IMPLAN model developed for such forecasting purposes. Maryland has access to this model through an intergovernmental cooperation understanding. The model has been modified for variations in economic structure among Maryland's regions. The model produces five different economic impact indicators for each of Maryland's 461 economic sectors. These economic impact indicators include: gross sales, employee income, total income, value added and employment. The fiscal impact indicators include state retail sales tax receipts, state personal income tax receipts, local personal income surtax and other local tax revenues.

The Maryland Economic Impact Model can be used to generate economic models for specified regions of Maryland or for the state as a whole. These models describe the interindustry flow of goods and services within a region and with the outside economy. In addition to single-region modeling, the Office of

Research has developed a viable technique for building multiregional economic impact models. These models allow estimation of trade among Maryland regions. The multiregional models measure the economic impact of an activity on the economy of the region in which the activity is located and on the economy of every other Maryland region.

These models (both single-region and multiregional) require accurate and detailed data on various aspects of a project or activity. For example, to assess the economic impact of the Christopher Columbus Center of Marine Research and Exploration, detailed data were obtained for construction and annual operations of the major components of the Center.

CHAPTER II
THE ECONOMIC IMPACT OF THE PROPOSED
CHRISTOPHER COLUMBUS CENTER

Impact of Construction Activities
on the Economy of Maryland

The construction of the proposed Christopher Columbus Center will have significant economic and fiscal impacts in Maryland. The construction cost estimates for the Center are expressed in 1989 dollars. The analysis, therefore, is not sensitive to the actual completion dates of the project, should unanticipated delays be experienced. The projected economic and fiscal impacts of the construction phase also are expressed in 1989 dollars.

The economic and fiscal impacts of the construction of the Christopher Columbus Center are expressed as net impacts. In other words, these impacts represent infusion of new spending, jobs and taxes in Maryland during the construction of the project. On the other hand, the annual impact of operations is expressed as gross impacts, since most of these operations currently exist in Maryland. Data and projections indicate,

however, that the scale of operations of each activity will substantially increase when relocated to the Christopher Columbus Center.

The projected total construction costs of \$100.47 million for all three elements of the Center are illustrated in 1989 dollars. The construction cost estimates are provided by the Christopher Columbus Center of Marine Research and Exploration, Inc., the Maryland Biotechnology Institute and by the University of Maryland, Baltimore County Campus. The estimates of construction expenditures and their associated economic and fiscal impacts do not include expenditures by the City of Baltimore on Piers 5 and 6, parking garage, land acquisition, site improvements and project management.

The construction expenditures for the three elements of the Christopher Columbus Center include:

- 1) An estimated \$53.22 million cost of constructing the Center of Marine Biotechnology. This includes \$45.22 million in direct architectural and engineering fees, construction of the base building and site improvements (bulkhead and promenade plaza). The total direct construction cost also includes an estimated \$8 million in expenditures for the initial start-up equipment. The breakdown of construction cost data was provided by the Maryland Biotechnology Institute.

- 2) An estimated \$3.95 million cost of constructing the Center of Marine Archaeology. This includes an estimated \$150,000 expenditures on the initial start-up equipment. The construction cost data were provided by the Christopher Columbus Center of Marine Research and Exploration, Inc., and by the University of Maryland, Baltimore County Campus.
- 3) An estimated \$43 million cost of constructing the Maritime Exhibition/Conference Center. This estimate was provided by the Christopher Columbus Center of Maritime Research and Exploration, Inc.

The impact from the construction phase of the proposed Christopher Columbus Center on the economy of Maryland is shown in table 1. The "total impact" of construction on the economy of Maryland amounts to over \$152 million of gross output or sales, over \$50 million of employee income and over 1,800 full-time equivalent jobs during the period of construction only.

The construction of the Center of Marine Biotechnology is estimated to generate over one-half of all economic impacts --- \$80 million of gross output \$27 million of employee income and nearly 980 jobs during the construction period. The total economic impact due to the construction of the Center of Marine Archaeology amounts to an estimated \$6 million in gross output,

Table 1
The Economic Impact from Construction of the Christopher Columbus Center
in Maryland (Construction Phase Only)
- 1989 Dollars -

Construction Project	Gross Output (\$MM)	Employee Income (\$MM)	Employment (Jobs)
Center of Marine Biotechnology			
Direct	\$53.22	\$18.42	544
Secondary	27.20	8.47	434
Total	80.42	26.89	978
Center of Marine Archeology			
Direct	3.95	1.35	39
Secondary	2.03	0.63	32
Total	5.98	1.98	71
Maritime Exhibition/Conference Center			
Direct	43.30	14.72	421
Secondary	22.32	6.99	351
Total	65.62	21.71	772
Total Construction			
Direct	\$100.47	\$34.49	1,004
Secondary	51.55	16.09	817
Total	152.02	50.58	1,821

Sources: Christopher Columbus Center of Marine Research and Exploration;
University of Maryland, Baltimore County;
Maryland Biotechnology Institute; and
DEED, Office of Research.

about \$2 million in employee income and about 70 full-time equivalent jobs during the construction period. Finally, the construction of the Maritime Exhibition/Conference Center is estimated to generate a total of nearly \$66 million in gross output, about \$22 million in employee income and over 770 jobs during the construction period.

The total impact is divided into "direct impact" and "secondary impacts." The direct impact refers to the construction industry's own impact on the local economy. It includes the direct (initial) architectural and engineering fees, construction of the base building, site improvements and initial start-up equipment. The construction of the proposed Christopher Columbus Center, in addition to generating additional spending in the economy statewide will produce substantial employment in Maryland's construction industry. Thus, the direct impact also represents direct labor and payroll associated with the construction of the Center. The following are excluded from the construction impact: land acquisition cost, parking garage and project management. The secondary impacts result from: 1) the construction industry's purchases from other Maryland industries; 2) outputs produced by Maryland industries to supply the input needs of the supporting industries selling directly to the construction sector; and 3) induced outputs resulting from the increased demand created by employees and owners of the construction industry and all other supplying sectors spending their incomes in Maryland.

Similar to the direct impact, the construction of the proposed Christopher Columbus Center, in addition to generating secondary impacts (outputs) in various Maryland industries, will generate secondary employment in the same industries. Our economic impact model, used to quantify the contribution of the construction of the proposed Center to the economy of Maryland, in our intermediate calculation estimates the number of these secondary jobs and their corresponding payroll.

The expenditures associated with the construction of the proposed Christopher Columbus Center and their corresponding economic impacts generate substantial tax revenues for the state and local governments. These revenues include, but are not limited to, state retail sales tax, state personal income tax, local personal income surtaxes and hotel occupancy tax. State retail sales tax receipts include tax revenues from expenditures by employees of the construction industry and all other supplying sectors spending their incomes. State income tax receipts include the state tax on employee income but exclude yields from the corporate income tax. State business tax receipts are not estimated because of the complexities in business taxes from industry to industry statewide and the variation within firms in a given industry. Local personal income surtax receipts are based on county or Baltimore City tax rates. Similarly, hotel occupancy tax receipts are based on local hotel/motel occupancy tax rates. This latter local tax revenue is applicable to the

annual operations phase, but not to the construction phase.

Table 2 summarizes the fiscal impact from construction activities on selected state and local tax revenues. The projected total increase in state and local tax revenues as a consequence of the increased economic activity statewide will amount to about \$420,000 in state retail sales tax receipts, about \$1.6 million in state personal income tax receipts and over \$790,000 in local personal income surtaxes during the construction period only. The total fiscal (tax) impact of construction will, therefore, amount to \$2.8 million in additional tax revenues during the period of construction activity.

The construction of the Center of Marine Biotechnology is estimated to generate approximately \$1.5 million in selected state and local taxes during the construction period, nearly 54 percent of the total fiscal impact. Similarly, the fiscal impact of construction of the Center of Marine Archaeology amounts to an estimated \$110,000 in selected state and local taxes. The construction of the Maritime Exhibition/Conference Center is projected to generate about \$1.2 million in state and local tax receipts.

Table 2
 Projected Fiscal Impact from Construction Activities
 of the Proposed Christopher Columbus Center
 (Construction Phase Only)
 - Thousands of 1989 Dollars -

Construction Category	State Taxes		Local Tax	Total
	Retail Sales	Personal Income	Income Surtax	
Center of Marine Biotechnology	\$220	\$850	\$425	\$1,495
Center of Marine Archeology	20	60	30	110
Maritime Exhibition/Conference Center	180	670	335	1,185
Total	\$420	\$1,580	\$790	\$2,790

Sources: Christopher Columbus Center of Marine Research and Exploration;
 University of Maryland, Baltimore County;
 Maryland Biotechnology Institute; and
 DEED, Office of Research.

Impact from Annual Operations on the Economy of Maryland

The projected annual economic impact from the operation of the proposed Christopher Columbus Center is based on the expenditures generated by all three elements of the Center when they are constructed and operating at targeted capacities. These are gross economic impact estimates, as some research activities initially will be transferred from other Maryland locations. Similar to the economic impact of the Center during the construction phase, all projections are expressed in 1989 dollars.

The annual economic impact from the operations of the Center of Marine Biotechnology is based on the COMB's budgetary projections at its targeted capacity. The economic impact of the COMB also includes projected expenditures incurred by approximately 3,750 delegates annually attending scientific conferences to be sponsored by the COMB in Baltimore City. According to the Maryland Biotechnology Institute, once full capacity is reached in FY 1996, the Institute and its component centers are expected to sponsor three scientific conferences with an average delegate size of 1,000 each and about five scientific conferences with an average delegate size of about 150 persons each.

At full capacity (FY 1996), the Center of Marine Biotechnology is projected to directly employ about 548

scientists, student researchers, administrators and support staff with an estimated annual payroll of \$17.26 million (including fringe benefits) in 1989 dollars. In addition, the COMB's other annual operating expenditures include an estimated \$2.24 million on supplies, \$2 million on maintenance, and about \$3 million on equipment.

The Center of Marine Biotechnology's projected expenditures on equipment are based on the Maryland Biotechnology Institute's budgetary projections for FY 1990, FY 1993 and FY 1996. Accordingly, the COMB anticipates spending nearly \$1 million in FY 1990, about \$2 million in FY 1993 and about \$3 million in FY 1996 on various scientific equipment. Based upon the COMB's experience and the fact that most scientific equipment have relatively short useful lives, we assumed an average useful life of five years for equipment purchased during the 1990-1996 period.

It is important to note again that these annual cash flows represent the initial three or four years of full-time operation. The level of operations may increase over time, and concurrently the annual cash flows for the COMB will also increase.

The economic impact of delegate spending of those attending conferences sponsored by the Center of Marine Biotechnology in Baltimore City is estimated using our Tourism Economic Impact Model. The model estimates average daily expenditures of a

conference/convention delegate overnighting in the City of Baltimore using various field surveys conducted by this Office. Assuming an average length of stay of 2.5 days, total annual direct delegate spending in the City of Baltimore amounts to an estimated \$1.9 million in 1989 dollars.

Similarly, the annual economic impact from the operations of the Center of Marine Archaeology is based on the COMA's budgetary projections at its targeted capacity. The Center of Marine Archaeology's annual economic impact also includes impacts generated by about 1,200 delegates attending an annual conference to be sponsored by the COMA in Baltimore City. According to the University of Maryland, Baltimore County, this scientific conference will attract scholars from major archaeology research centers in the U.S. and abroad.

At targeted capacity (FY 1996), the Center of Marine Archaeology is projected to directly employ on site about 33 scientists, student researchers, administrators and support staff, with an estimated annual payroll of about \$1.3 million (including fringe benefits) in 1989 dollars. The COMA's other annual operating expenditures include an estimated \$140,000 on maintenance, \$80,000 on supplies, \$100,000 on contracts and nearly \$60,000 on equipment.

The Center of Marine Archaeology's planned annual conference is projected to generate about \$600,000 in annual delegate

spending in 1989 dollars.

The annual economic impact from the operations of the Maritime Exhibition/Conference Center is based on the projected number of visitors to the Maritime Exhibition and their daily expenditures. The number of visitors projected to attend the Maritime Exhibition was provided by Joseph A. Wetzel Associates, Inc., a planning and design firm specializing in museums, zoos and aquariums. Based on the annual attendance of other maritime exhibitions and museums at the Inner Harbor, Wetzel Associates anticipates that annual attendance at the proposed Maritime Exhibition/Conference Center will be in the 350,000-400,000 range.

This study assumes the lower attendance figure of 350,000 for the analysis. Obviously, not all attendees are in the local community because of the Maritime Exhibition/Conference Center. Some attendees are local residents who travel a short distance to visit the Maritime Exhibition and many other attractions of Baltimore's Inner Harbor. Other attendees may include tourists from out-of-state or in-state residents who travel at least 30 miles or more away from home to visit Baltimore City. These tourist may add a Maritime Exhibition visitation to their planned activity as a side trip. However, if the Maritime Exhibition is the primary reason for their visitations and/or inducement to overnight in Baltimore, then part or all of their spending in Baltimore City should be credited to the existence of the

Maritime Exhibition. Thus, we assume that only 15 percent of the exhibition visitors are attracted to the City of Baltimore because of the exhibitions held at the Maritime Exhibition/Conference Center. Using our Tourism Economic Impact Model, these visitors were distributed among three categories of lodging in the City of Baltimore -- hotels and motels, home of friends or relatives, and day trips. An average daily spending was then specified for each lodging type and applied to the number of tourist days in their corresponding lodging group. Thus, using our Tourism Economic Impact Model, Maritime Exhibition visitation generates over \$3.7 million in direct tourist spending in the city of Baltimore (1989 dollars). Due to the paucity of data, annual operating budgets of the Maritime Exhibition/Conference Center could not be estimated. Part of the operating expenditures of the Maritime Exhibition/Conference Center are built into COMB and COMA operation.

The direct spending associated with the operations of the Center of Marine Biotechnology, the Center of Marine Archaeology and the Maritime Exhibition/Conference Center generate important secondary impacts in the economy of Maryland. This rippling effect takes place when local vendors increase their production and purchases in order to meet additional demand imposed on them by the Christopher Columbus Center's annual operations. Finally, increased consumer spending by the employees of both the Christopher Columbus Center and its supporting businesses provide yet additional economic activity in the community.

Table 3 summarizes annual economic impact of the proposed Christopher Columbus Center in Maryland. The total annual economic impact of the proposed Center of Marine Biotechnology amounts to an estimated \$49.8 million of gross output, \$24.4 million of employee income and over 1,070 jobs statewide, in each case about four-fifths of the total economic impact. The total annual economic impact of the proposed Center of Marine Archaeology amounts to about \$4 million in gross output, \$1.9 million in employee income and over 70 jobs. Finally, the annual economic impact of the proposed Maritime Exhibition/Conference Center amounts to over \$10.7 million in gross output, \$3.2 million in employee income and about 130 jobs.

The total annual economic impact of the Christopher Columbus Center of Marine Research and Exploration is estimated to be \$57 million of gross output, \$27 million of employee income and over 1,180 full-time equivalent jobs.

Recurring Annual Fiscal Impacts From Operations

Similar to the fiscal impact of construction activities, the fiscal (tax) impacts from operations of the three elements of the Christopher Columbus Center --- Center of Marine Biotechnology, Center of Marine Archaeology, and the Maritime Exhibition/Conference Center --- are estimated for selected state

Table 3
Annual Economic Impact of the Christopher Columbus Center in Maryland
- 1989 Dollars -

Operations Category	Direct Impact			Total Impact		
	Gross Output (\$M)	Employee Income (\$M)	Employment (jobs)	Gross Output (\$M)	Employee Income (\$M)	Employment (Jobs)
Center of Marine Biotechnology						
Annual Operations	\$22.50	\$14.38	548	\$36.81	\$20.50	911
Annual Conferences	1.88	--	--	5.40	1.63	67
Total	24.38	14.38	548	42.21	22.13	978
Center of Marine Archeology						
Annual Operations	1.64	1.02	33	2.34	1.35	53
Annual Conferences	0.60	--	--	1.73	0.52	21
Total	2.24	1.02	33	4.07	1.87	74
Maritime Exhibition/Conference Center						
Visitor Spending	3.75	--*	--*	10.72	3.23	130
All Activities	30.37	15.40	581	57.00	27.23	1,182

*included under COMB and COMA

Sources: Christopher Columbus Center of Marine Research and Exploration;
University of Maryland, Baltimore County;
Maryland Biotechnology Institute; and
DEED, Office of Research.

and local taxes. These taxes include state retail sales tax, state personal income tax, local personal income surtax, and local hotel occupancy tax.

Table 4 summarizes the projected total annual increase in state and local tax revenues as a consequence of increased economic activity statewide. The contribution of the Center of Marine Biotechnology to the state and local tax receipts amounts to \$319,000 in retail sales tax receipts, \$848,000 in state personal income tax receipts, \$419,000 in local personal income surtaxes and about \$5,000 in local hotel occupancy tax receipts. The total annual fiscal impact from the activities of the Center of Marine Biotechnology is, therefore, estimated to be \$1.6 million to the state and local jurisdictions in 1989 dollars.

The Center of Marine Archaeology is projected to generate about \$45,000 in annual state retail sales tax receipts, \$68,000 in state personal income tax receipts, \$29,000 in local personal income surtaxes and about \$2,000 in local hotel occupancy tax receipts. The Center of Marine Archaeology's total annual contribution to the state and local tax receipts amounts to an estimated \$144,000 in 1989 dollars.

Finally, the fiscal impact of visitor spending associated with the Maritime Exhibition/Conference Center is estimated to be about \$217,000 in state retail sales tax receipts, \$113,000 in state personal income tax receipts, \$56,000 in local income

Table 4
Projected Annual Fiscal Impact from Operations of the
Attendant Activities at the Christopher Columbus Center
- Thousands of 1989 Dollars -

Impact Category	State Taxes		County Taxes		Total
	Retail Sales	Personal Income	Personal Income	Hotel Occupancy	
Center of Marine Biotechnology					
Annual Operations	\$210	\$790	\$390	\$0	\$1,390
Annual Conferences	109	58	29	5	201
Total	319	848	419	5	1,591
Center of Marine Archeology					
Annual Operations	10	50	20	0	80
Annual Conferences	35	18	9	2	64
Total	45	68	29	2	144
Maritime Exhibition/Conference Center					
Visitor Spending	217	113	56	58	444
All Activities	\$581	\$1,029	\$504	\$65	\$2,179

Sources: Christopher Columbus Center of Marine Research and Exploration;
University of Maryland, Baltimore County;
Maryland Biotechnology Institute; and
DEED, Office of Research.

surtaxes and about \$58,000 in local hotel occupancy tax receipts. The total annual fiscal impact from the Maritime Exhibition/Conference Center visitor spending amounts to about \$444,000 in 1989 dollars.

The total annual fiscal impact from the operations of the Christopher Columbus Center of Marine Research and Exploration amounts to an estimated \$2.2 million in selected state and local taxes in 1989 dollars. Operating budgets are for annual staffing and workloads for the initial three or four years of full-time operation. As the scale of the Christopher Columbus Center grows (in real dollars), the annual economic and fiscal impacts will concurrently increase.

CHAPTER III

NEW PRODUCTS - NEW FIRMS - NEW JOBS CHRISTOPHER COLUMBUS LONG RUN CONTRIBUTION TO THE STATE OF MARYLAND

Overview

When we speak of employment and production, we can most easily envision the productive process that generates real goods or services. An auto assembly plant builds motor vehicles. So many minutes of communications are generated over a telecommunications network and so on.

The proposed Christopher.Columbus Center and similar academic-oriented research and development enterprises have a distinctively different kind of "product." The end objective of these basic and applied research facilities is the discovery of new ideas, concepts and processes. Some of these concepts and processes sequentially lead to new commercial products and processes, some of which can be patented. This is the truly exciting aspect of the Christopher Columbus Center: the discovery of ideas and the development of new products and processes.

Researchers at the Christopher Columbus Center may innovate a product or process that can be licensed for production and distribution in the private sector. Alternatively, Christopher Columbus researchers may succeed in basic research that in turn will provide the "key" to be integrated in other commercial applications in the private sector.

The scientific communities in a general sense "serve the world." But much of the commercial application of Christopher Columbus Center's research will for good reasons be focused on the greater Baltimore region. Time and timing are critical for commercial success in highly sophisticated technical fields. Firms with products directly linked to marine biology and related fields will locate near the Christopher Columbus Center in order to forge formal and informal links with the Center's researchers and laboratories. Some business/academic arrangements may be contracts, cooperative agreements and joint ventures. Other links will be the informal networking of information and ideas that takes place when individuals of similar professional background congregate or cluster around a renowned research center. Why try to create and innovate ideas in a vacuum out in the hinterland when one can enjoy the stimulation and creativity from close contact with cutting-edge researchers at an internationally-renowned Center of Excellence? In this era of global communications, one can transmit an idea worldwide in a matter of seconds. But messages must be transmitted or broadcast

to be received. So much information in the research process is not "broadcast" at all, or is disseminated only on completion of a research project. Therefore, there is a very real time and timing advantage for select commercial firms to locate in close proximity to the proposed Christopher Columbus Center so that researchers can relate to each other throughout the research process.

The economic contributions of the Christopher Columbus Center to Maryland (and to the United States) in the long run must be measured by the new and expanded firms, new products and all additional net new jobs that can be directly attributed to research and the researchers at the Center.

Visionaries Vs. Accountants

Calculated risktaking can generate significant rewards. Research, particularly basic research, assumes risk. One may not even be able to assign a probability of success to certain research undertakings. Given a research success, there may be a need for further investment before a commercially-successful product emerges.

But calculated risktaking is absolutely critical in a sophisticated and growing economy, and risktaking in financing research is the very core of innovation and development. This is

not to suggest that any and all research proposals ought to be funded. In a world of tight budgets, research projects must be prioritized. But certain concepts widely used in other aspects of financial management such as internal rates of return and breakeven points may not be applicable to investment decisions regarding research. This observation frequently is cited as one explanation for the apparent bias in many major U.S. corporations to invest in product design cosmetics rather than in basic and applied research.

The Christopher Columbus Center's principal function is research. Individual researchers identified to date as probable faculty members in components of the proposed Christopher Columbus Center have achieved national and global reputations among scientific communities for accomplishments in their respective fields. Their demonstrated capabilities as applied researchers increase the probabilities of "success" from investing in the Christopher Columbus Center. Such a Center of Excellence is of sufficient scale to induce a "critical mass" of expertise for sustained growth and the spinning-off of new products, new processes, new companies.

Other New Centers of Excellence in the United States

What new products?

What new processes?

What new companies?

We can pose but cannot answer definitively these questions. Rather, we can look to the performance of centers of excellence in other high technology disciplines. As of 1988, 29 states claim to have Technology and Research Centers of one kind or another (Minnesota Department of Trade and Economic Development, State Technology Programs in the United States, 1988). These programs vary from research parks and technology transfer systems to genuine business/university centers of excellence. We identify about fifteen states with research centers similar to the proposed Christopher Columbus Center in organization and operation. These precedent centers of excellence in other states each focus on one field of high technology research, organized around the outstanding research facility of their respective state university or universities. Many high technology fields are represented in these 15 states, as each state perceives competitive advantages in one or more fields. No established center of excellence concentrates specifically on marine biotechnology and marine archaeology, as these two fields will establish unique opportunities for Maryland in international

competition.

These fifteen states that presently are investing in centers of excellence are developing a new and exciting concept in collaborative high technology research and development. Most of these centers of excellence have been established in the past five years. Few centers have available at this time progress reports or accountability statements, as it seems to take a minimum of three or four years before significant new employment effects from research to commercial application can be identified.

We had to search and interview for centers with definitive progress reports, rather than take marketing plans and future goals as a rationale for the establishment of the Christopher Columbus Center. Three states have specific information to provide some insight on the economic future of Baltimore and Maryland as regards the proposed Christopher Columbus Center: Kansas, New York and Ohio.

Kansas has established four centers of excellence to date, the Center for Bioanalytical Research in 1983, the Center for Research in Computer Controlled Automation in 1984, the Institute for Aviation Research in 1985 and the Center for Technology Transfer in 1988. The 1988 Annual Report for the four centers lists the following achievements during the period FY 1984-FY1988:

- o \$2.1 million in state funds was leveraged with \$1.9 million in industry funding and \$1.1 million in federal funding
- o \$15 million in new venture capital was created
- o 15 new technologies had been developed
- o 6 patents had been issued or were pending
- o 5 new companies were formed
- o 200 jobs were created or saved

Effects are cumulative and take several years to begin to show results. Kansas is expecting that by 1991, its four centers of excellence will have created or retained 478 jobs and produced at least \$14.7 million in sales by its sponsor companies of products developed by the centers of excellence. This gradual evolution of net new local economy jobs attributed to Kansas' centers of excellence in their first decade of operation is indicative of the patience and continued support one must have in basic research. A center of excellence is no "quick fix" for local economic problems. Rather, it is a solid investment that will yield accelerating returns for future generations.

In New York there are nine Centers for Advanced Technology. Two of them were established during the fiscal year 1987-88, and the other seven were created in 1983. The 1987-88 Annual Report lists the following accomplishments.

- o 26 patents awarded

- o 33 patents pending
- o 7 spin-off companies in operation
- o 4 more under development, as well as
- o 750 students trained in specific advanced high technology unique to their disciplines

New York state invested \$9 million in their CATS in 1987-88 and leveraged that with \$17 million during the fiscal year. New York is planning to open a Center for Automation and Robotics in the near future.

Ohio has nine Centers of Excellence. One of these is the Edison Polymer Innovation Corporation, established in 1984. It reported to the State in July of 1988 that 75 companies (55 of them located in Ohio) were supporting members of the Center. Funds provided by industry amounted to \$1 million in FY1987-FY1988 and were projected to increase to \$1.7 million by FY1989-FY1990. As of July 1988, the Polymer Innovation Center reported:

- o 1 patent granted
- o 7 patents pending
- o 5 start-up firms assisted
- o 170.5 jobs created or saved
- o 2 out-of-state companies planning new facilities in Ohio.

As of December 14, 1989, 3 additional patents have been applied for and a licensing procedure has been established to

cover five additional technologies.

Most of the other Ohio centers do not have information which is as complete as the information from the Polymer Innovation Center. However, the Edison Welding Institute reports that its budget totals \$9 million, 80% of which is provided by industry. It expects to be independent of funding from the State of Ohio within the next three to four years.

Categories of "Net New Economic Activity" As A Consequence of
Christopher Columbus Center's Research Work

The technology transfers and technology applications from the proposed Christopher Columbus Center to meet the needs of Maryland's businesses and economy will be accomplished by several processes.

First, this is a graduate center for advanced education in marine biology and in maritime archaeology. The Center will produce a graduating class each year of scientists skillfully trained in most advanced technologies, research methods, and an exposure to the leading edge of research in these critical fields of marine biotechnology and marine archaeology. The Christopher Columbus Center and other such advanced graduate centers truly serve the nation. Some of Maryland's most valuable "exports" to other states in the future will be graduates from the Christopher

Columbus Center's program. This is one tremendous national return to Federal Government investment directly in the Christopher Columbus Center and grants for specific research programs and projects.

Many outstanding graduates will remain in Baltimore and other areas of the state. The promise of these young researchers is one of the strong magnets that cause existing firms that are manufacturing products based on marine biotechnical research to relocate to Maryland or to establish a regional facility in Baltimore. It is a self-fulfilling prophesy. Private sector firms will cluster near or within a reasonable distance to Christopher Columbus in order to do collaborative research and to "loan" researchers on a reciprocal basis. Promising graduate students will be hired by these firms for summer appointments and for cooperation agreement joint research. This is the courtship process. Many graduate students form strong emotional bonds with their graduate center and welcome professional opportunities to stay in the area. The private sector firms acquire the research talent necessary to maintain growth and, in growing, will bid for additional new graduate student interns to join their firms.

First crack at promising graduate students is but one reason why existing high technology firms will relocate to Maryland and cluster near the Christopher Columbus Center. The U.S. now is engaged in accelerated competition with other nations for new products and technology. The ability to duplicate new technology

or productive processes worldwide that would have been innovated in the United States has increased the pressure for private sector firms and academic research centers to collaborate throughout the research stage so that new information and technology can be transferred from the research laboratory to volume commercial application in the shortest possible time. No longer can the research and development process be linear, where academic research laboratories complete, test, and announce research results in ivory tower isolation, followed by preliminary exploration by the research elements of private firms seeking possible commercial applications. A tremendous lead time advantage over potential foreign competition would be forfeited. The United States is still in the exploratory stage of business/university partnership and collaborative research between academic research centers and consortium of private firms who themselves may be competitive. But as international competition changes, American institutions must be open to change. The promise of Christopher Columbus Center's innovative approaches to collaborative research and technology transfer will serve as a model for other new centers of excellence in the nineties.

Those existing firms that will relocate to Maryland to be close to the proposed Christopher Columbus Center will be a net new economic activity to this state and would be counted as a positive economic impact for Maryland. There would be no initial gain to the U.S. in this abstract example, however. Maryland's

gain is merely a transfer from other states. The added net gain both for Maryland and the U.S. is the additional production and new jobs generated from the technology transfer by the Christopher Columbus Center to that firm. Furthermore, the DEED Office of Technology Development and other divisions of DEED are in place and prepared to assist in worker training, innovative financing, international marketing opportunities, and other considerations to accelerate the production process.

Another category of new economic activity that will be a direct product of Christopher Columbus Center's research is the incubator firms that will be "hatched" to develop commercial applications. The University of Maryland and Johns Hopkins University both have incubator facilities (University of Maryland and Johns Hopkins University in Baltimore and University of Maryland in College Park) that provide low overhead costs and pooled services to fledgling high tech firms. These incubators are highly suited to medical-related, pharmacology-related and marine biotechnology-related incubator firms. The Christopher Columbus Center itself may establish incubator facilities or assist in arranging for leased space in several possible buildings within walking distance to the Center as operations warrant. The "disappearance rate" of such incubator firms in the past has been mixed --- a combination of mortality plus absorption or merger with existing firms. But the focused assistance that the State, local government and the host university now provide the incubator firms will jointly create a

higher probability for the commercial success of these firms. Moreover, the success and expansion process is accelerated. The payoff for Maryland is those home grown firms that survive, thrive, and expand. These are the bright, new, exploding high technology firms that both will directly and in total economic impact provide that expanded employment and high tech base for Maryland, the High Tech State for the Nineties.

